BAYOU BONNE IDEE TMDLS FOR DISSOLVED OXYGEN, NUTRIENTS, NITROGEN, AND PHOSPHORUS

May 28, 2002

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FOR DISSOLVED OXYGEN, NUTRIENTS, NITROGEN, AND PHOSPHORUS

SUBSEGMENT 080902

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EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to identify waterbodies that are not meeting water quality standards and to develop total maximum daily pollutant loads for those waterbodies. A total maximum daily load (TMDL) is the amount of pollutant that a waterbody can assimilate without exceeding the established water quality standard for that pollutant. Through a TMDL, pollutant loads can be distributed or allocated to point sources and nonpoint sources (NPS) discharging to the waterbody. This report presents TMDLs that have been developed for dissolved oxygen (DO) and nutrients for Bayou Bonne Idee (subsegment 080902), in the Ouachita River basin in northern Louisiana.

Bayou Bonne Idee is located east of Bastrop, Louisiana. The drainage area for Bayou Bonne Idee is approximately 68 square miles. The stream is located in a region where the land use is largely agricultural and the topography is generally flat. There are four small dams along Bayou Bonne Idee. The only known point source discharge in this subsegment is the Village of Bonita Sewage Treatment Plant (STP).

Subsegment 080902 was listed on the Modified Court Ordered 303(d) List for Louisiana as not fully supporting the designated use of propagation of fish and wildlife and was ranked as priority #2 for TMDL development. The causes for impairment cited in the 303(d) List included organic enrichment/low DO, nutrients, nitrogen, and phosphorus. The water quality standard for DO for this subsegment is 5 mg/L year round.

A water quality model (LA-QUAL) was set up to simulate DO, CBOD, ammonia nitrogen, and organic nitrogen in the subsegment. The model was set up and calibrated using LDEQ historical data collected during 1983, data from a synoptic survey conducted by FTN Associates, Ltd. (FTN) during August 2001, and other information obtained from LDEQ and USGS. There were no intensive survey data available for this subsegment. The projection simulation was run at critical flows and temperatures to address seasonality as required by the Clean Water Act. Reductions of existing NPS loads were required for the projection simulation to show the DO standard of 5 mg/L being maintained. In general, the modeling in this study was consistent with guidance in the Louisiana TMDL Technical Procedures Manual.

A TMDL for oxygen demanding substances (CBOD, ammonia nitrogen, organic nitrogen, and sediment oxygen demand) was calculated using the results of the projection simulation. Both implicit and explicit margins of safety were included in the TMDL calculations. The nutrient TMDL was developed based on Louisiana's water quality standard for nutrients, which states that "the naturally occurring range of nitrogen to phosphorus ratios shall be maintained". The nutrient TMDL was calculated using allowable nitrogen loadings from the projection simulation and applying a naturally occurring nitrogen to phosphorus ratio to determine the allowable phosphorus loadings.

Each TMDL for this subsegment includes a wasteload allocation (WLA) for the Village of Bonita STP and a load allocation for NPS loads. The results of the modeling and TMDL calculations showed that NPS loads will need to be reduced by approximately 82% to meet the DO standard of 5 mg/L throughout Bayou Bonne Idee. No load reduction or treatment upgrade was recommended for the Village of Bonita STP because the oxygen demanding load that it currently contributes to Bayou Bonne Idee is small and the predicted minimum DO for critical conditions occurred more than 50 km downstream of the STP.

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1.0 INTRODUCTION

This report presents total maximum daily loads (TMDLs) for dissolved oxygen (DO) and nutrients for Bayou Bonne Idee, subsegment 080902. This subsegment was listed on the February 29, 2000 Modified Court Ordered 303(d) List for Louisiana (EPA 2000) as not fully supporting the designated use of propagation of fish and wildlife. The suspected sources and suspected causes for impairment in the 303(d) List are included in Table 1.1. Subsegment 080902 was ranked as priority #2 for TMDL development. The TMDLs in this report were developed in accordance with Section 303(d) of the Federal Clean Water Act and EPA's regulations at 40 CFR 130.7. The 303(d) Listings for other pollutants in this subsegment are being addressed by EPA and the Louisiana Department of Environmental Quality (LDEQ) in other documents.

The purpose of a TMDL is to determine the pollutant loading that a waterbody can assimilate without exceeding the water quality standard for that pollutant and to establish the load reduction that is necessary to meet the standard in a waterbody. The TMDL is the sum of the wasteload allocation (WLA), the load allocation (LA), and a margin of safety (MOS). The WLA is the pollutant load allocated to point sources of the pollutant of concern, and the LA is the pollutant load allocated to nonpoint sources (NPS). The MOS is a percentage of the TMDL that accounts for the uncertainty associated with the model assumptions, data inadequacies, and future growth.

Table 1.1. Summary of 303(d) Listing of subsegment 080902 (EPA 2000).

Subsegment Number	Waterbody Description	Suspected Sources	Suspected Causes	Priority Ranking (1 = highest)
080902	Bayou Bonne Idee	Irrigated crop production Agriculture	Organic enrichment/low DO Suspended solids Pesticides Nutrients Nitrogen Phosphorus	2

2.0 STUDY AREA DESCRIPTION

2.1 General Information

Bayou Bonne Idee (subsegment 080902) is located east of Bastrop in the Ouachita River basin in northern Louisiana (see Figure A.1 in Appendix A). Bayou Bonne Idee extends approximately 95 km from its headwaters near Bonita to its confluence with the Boeuf River. The drainage area of Bayou Bonne Idee at the mouth is approximately 68 square miles. Four dams (located as shown on Figure A.2) have been constructed along the stream and water is pumped from the stream for irrigation. As shown in Table 2.1, the primary land use in the Bayou Bonne Idee watershed is agriculture. Much of the agricultural land is cropland.

Table 2.1. Land uses in subsegment 080902 based on GAP data (USGS 1998).

Land Use Type	% of Total Area
Fresh Marsh	0.8%
Wetland Forest	13.3%
Upland Forest	0.1%
Wetland Scrub/Shrub	0.1%
Upland Scrub/Shrub	0.0%
Agricultural	76.9%
Urban	0.0%
Water	8.8%
Barren Land	0.0%
TOTAL	100.0%

2.2 Water Quality Standards

The numeric water quality standards and designated uses for this subsegment are shown in Table 2.2. The primary numeric standard for the TMDLs presented in this report is the DO standard of 5 mg/L year round.

Table 2.2. Water quality standards and designated uses (LDEQ 2000).

Subsegment Number	080902
Waterbody Description	Bayou Bonne Idee – Headwaters to Boeuf River
Designated Uses	ABC
Criteria:	
Chloride	20 mg/L
Sulfate	10 mg/L
DO	5 mg/L (year round)
pH	6.0-8.5
Temperature	32 °C
TDS	180 mg/L

USES: A – primary contact recreation; B – secondary contact recreation; C – propagation of fish and wildlife; D – drinking water supply; E – oyster propagation; F – agriculture; G – outstanding natural resource water; L – limited aquatic life and wildlife use.

For nutrients, there are no specific numeric criteria, but there is a narrative standard that states "The naturally occurring range of nitrogen-phosphorus ratios shall be maintained.... Nutrient concentrations that produce aquatic growth to the extent that it creates a public nuisance or interferes with designated water uses shall not be added to any surface waters." (LDEQ 2000).

In addition, LDEQ issued a declaratory ruling on April 29, 1996, concerning this language and stated, "That DO directly correlates with overall nutrient impact is a well-established biological and ecological principle. Thus, when the LDEQ maintains and protects DO, the LDEQ is in effect also limiting and controlling nutrient concentrations and impacts." DO serves as the indicator for the water quality criteria and for assessment of use support. For the TMDLs in this report, the nutrient loading required to maintain the DO standard is the nutrient TMDL.

2.3 Identification of Sources

2.3.1 Point Sources

A listing of all NPDES permits in the Ouachita and Calcasieu River basins was searched to identify any permits within the Bayou Bonne Idee subsegment (080902). This listing was prepared by EPA Region 6 using databases and permit files from LDEQ. This listing showed 3 NPDES permits within subsegment 080902 (see Appendix B). However, during further review, FTN determined that 2 of the 3 point sources identified in the EPA listing are actually located outside the subsegment and discharge into streams that do not drain into Bayou Bonne Idee. The remaining point source, the Village of Bonita Sewage Treatment Plant (STP), was included in the modeling and TMDL calculations. The approximate location of this discharge is shown on Figure A.2 in Appendix A. Other relevant information for this discharge is listed below:

	Village of Bonita STP
Permit number:	LA0052141
Receiving stream	Bayou Bonne Idee
Design flow	0.06 MGD
Permit limits	10 mg/L BOD

2.3.2 Nonpoint Sources

The nonpoint sources that were cited as suspected sources of impairment in the 303(d) List (Table 1.1) were irrigated crop production and agriculture.

2.4 Previous Data and Studies

Listed below are previous water quality data and studies in or near the Bayou Bonne Idee subsegment. The locations of the LDEQ ambient monitoring stations are shown on Figure A.2 in Appendix A.

1. Monthly data collected by LDEQ for “Bayou Galion Cutoff East of Galion, Louisiana” (Station 0121) for February 1982 to November 1986.
2. Monthly data collected by LDEQ at the “Bayou Bonne Idee Northeast of Oak Ridge, Louisiana” (Station 0122) for February 1982 to December 1990 and January 1999 to December 1999.
3. Monthly data collected by LDEQ at the “Bayou Bonne Idee East of Mer Rouge, Louisiana” (Station 0125) for July 1982 to December 1990.
4. Monthly data collected by LDEQ at the “Bayou Bonne Idee Southeast of Mer Rouge, Louisiana” (Station 0126) for July 1982 to December 1990.
5. Monthly data collected by LDEQ at “Bayou Bonne Idee East of Galion, Louisiana” (Station 0127) for July 1982 to December 1990.

6. Data collected by USGS at "Bayou Bonne Idee near Mer Rouge, Louisiana" for November 1956.
7. Monthly data collected by USGS at "Bayou Bonne Idee near Oak Ridge, Louisiana" for April 1981 to March 1982.

3.0 CALIBRATION OF WATER QUALITY MODEL

3.1 Model Setup

In order to evaluate the linkage between pollutant sources and water quality, a computer simulation model was used. The model used for these TMDLs was LA-QUAL (version 4.13), which was selected because it includes the relevant physical, chemical, and biological processes and it has been used successfully in the past for other TMDLs in Louisiana. The LA-QUAL model was set up to simulate organic nitrogen, ammonia nitrogen, ultimate carbonaceous biochemical oxygen demand (CBODu), and DO.

The reach/element design and the location of the modeled inflows are shown on Figure A.3 in Appendix A. Bayou Bonne Idee was divided into six reaches to represent varying depths and widths along the stream and stream segments between dams. The reaches were divided into smaller elements because there will likely be some variation in water quality within each reach.

3.2 Calibration Period and Calibration Targets

An intensive field survey was not performed for the study area due to schedule and budget limitations. A synoptic survey of the study area was performed by FTN in August 2001, but only limited data were collected during that survey. The historical period for which water quality data were collected for all five LDEQ stations within the subsegment was July 1982 through November 1986 (see Section 2.4).

Water quality data were retrieved from the LDEQ website. These data are shown in Appendix C. The two conditions that usually characterize critical periods for DO are high temperatures and low flows. High temperatures decrease DO saturation values and increase rates for oxygen demanding processes (BOD decay, nitrification, and sediment oxygen demand (SOD)). In most systems, low flows cause reaeration rates to be lower. The purpose of selecting a critical period for calibration is so that the model will be calibrated as accurately as possible for making projection simulations for critical conditions.

Based on the data in Appendix C, the calibration period was selected as August 9 to September 13, 1983. This period represented the most critical period for DO. The calibration targets at each station location (i.e., the concentrations to which the model was calibrated) for each parameter was set to the average of the concentrations measured during the calibration period. The LDEQ routine monitoring data included DO, total Kjeldahl nitrogen (TKN), nitrate + nitrite, and total organic carbon (TOC) but did not include CBODu or ammonia nitrogen. The CBODu calibration targets were estimated from the TOC data based on statistics from LDEQ's long term BOD analyses. The LDEQ's long term BOD analyses consisted of 140 samples from intensive surveys in the Ouachita River basin during 2001. These samples were analyzed for numerous parameters including CBODu and TOC. The ratio of CBODu to TOC was calculated for each sample and the median of those 140 ratios was determined to be 1.10. Using this result, the CBODu calibration target was estimated as 1.10 times the average TOC during the calibration period. Data from the LDEQ long term BOD analyses are shown in Appendix D.

The ammonia nitrogen calibration targets were estimated by multiplying the average TKN concentrations during the calibration period times the median ratio of ammonia nitrogen to TKN from the FTN 2001 synoptic survey, which was 0.11. Data from the FTN 2001 synoptic survey are shown in Appendix E. Organic nitrogen was estimated as TKN minus ammonia nitrogen.

3.3 Temperature Correction of Kinetics (Data Type 4)

The temperature correction factors used in the model were consistent with the Louisiana Technical Procedures Manual (the "LTP"; LDEQ 2001). These correction factors were:

- Correction for BOD decay: 1.047 (value in LTP is same as model default)
- Correction for SOD: 1.065 (value in LTP is same as model default)
- Correction for ammonia N decay: 1.070 (specified in Data Group 4)
- Correction for organic N decay: 1.020 (not specified in LTP; model default used)
- Correction for reaeration: automatically calculated by the model

3.4 Hydraulics (Data Type 9)

The hydraulics were specified in the input for the LA-QUAL model using the power functions (width = a * Q^b + c and depth = d * Q^e + f). Widths were estimated from digital ortho quarter quad maps (DOQQs). Depths were estimated based on observed depth to width ratios from the 2001 FTN synoptic survey (see Appendix E). Under low flow conditions, the depths and widths in the model were assumed to be independent of flow rate because of backwater from the four dams along the stream. Therefore, the system was modeled with constant depth and width. This was specified in the model by setting the coefficients, exponents, and constants for each reach as follows (actual values are shown in Appendix F):

- width coefficient (a) = 0.0
- width exponent (b) = 0.0
- width constant (c) = estimated width
- depth coefficient (d) = 0.0
- depth exponent (e) = 0.0
- depth constant (f) = estimated depth

3.5 Initial Conditions (Data Type 11)

Because temperature is not being simulated in the model, temperature for each reach was specified in the initial conditions for LA-QUAL. The temperature for reaches 1 through 3 was set to the average temperature measured at station 0127 during the calibration period. For reaches 4, 5, and 6 the temperature was set to the average temperature measured at stations 0125, 0126, and 0122, respectively. The input data and sources are shown in Appendix F.

For constituents not being simulated, the initial concentrations were set to zero; otherwise, the model would have assumed a fixed concentration of those constituents and the model would have included the effects of the unmodeled constituents on the modeled constituents (e.g., the effects of algae on DO).

3.6 Water Quality Kinetics (Data Types 12 and 13)

Kinetic rates used in LA-QUAL include reaeration rates, CBOD decay rates, nitrification rates, and mineralization rates (organic nitrogen decay). The values used in the model input are shown in Appendix F.

Reaeration was specified in the model using a surface transfer coefficient (option 20). Because most of Bayou Bonne Idee is wide and not sheltered from the wind, the effect of wind on reaeration was included by calculating a wind-aided surface transfer coefficient. Because no wind data were available for the calibration period, long term average wind speeds from the Shreveport and Baton Rouge stations were used to calculate the wind-aided surface transfer coefficient. (Long term average wind speeds were not available for Monroe or any other stations that were closer to the study area). For each station, these wind speeds were averaged for the months of August and September, corrected to a height of 0.1 m, and then used to calculate a wind-aided surface transfer coefficient. These calculations yielded surface transfer coefficients of 1.01 m/day for Shreveport and 0.94 m/day for Baton Rouge. These two values were averaged to obtain the model input value of 0.97 m/day. These data and calculations are shown in Appendix G.

The rates for CBOD decay and nitrification (ammonia nitrogen "decay") were based on median values of laboratory decay rates from LDEQ's long term BOD analyses. The LDEQ long term BOD analyses consisted of 140 samples from intensive surveys in the Ouachita River basin during 2001. The median decay rates for CBOD and nitrogenous biochemical oxygen demand (NBOD) were approximately 0.06/day and 0.07/day, respectively. These data are shown in Appendix D. Because instream decay rates are typically slightly higher than laboratory decay rates, both the CBOD decay rates and the nitrification rates (NBOD) were set to 0.10/day for all reaches.

The mineralization rates (organic nitrogen decay) in the model were set to 0.02/day for all reaches. This value was similar to the values shown in Table 5.3 of the "Rates, Constants, and Kinetics" publication (EPA 1985) for dissolved organic nitrogen being transformed to ammonia nitrogen. The literature values for mineralization rates are shown in Appendix H.

One other input value was specified for characterizing the nitrification process. In the program constants section of the model input file (data type 3), the nitrification inhibition option was set to 1 instead of the default of option number 2. With the default option, the nitrification rate drops rapidly when the DO drops below 2 mg/L, which results in an unrealistic build up of ammonia nitrogen at low DO. Option number 1 provides nitrification inhibition that is similar to what is used in other water quality models such as QUAL2E and WASP (see Figure 3.5 in FTN 2000).

3.7 Nonpoint Source Loads (Data Types 12, 13, and 19)

The NPS loads that are specified in the model can be most easily understood as resuspended load from the bottom sediments and are modeled as SOD, benthic ammonia source rates, CBOD loads, and organic nitrogen loads. The SOD (specified in data type 12), the benthic ammonia source rates (specified in data type 13), and the mass loads of organic nitrogen and CBODu (specified in data type 19) were all treated as calibration parameters; their values were adjusted until the model output was similar to the calibration target values. The values used as model input are shown in Appendix F.

These four calibration parameters were adjusted in a specific order based on the interactions between state variables in the model. First the organic nitrogen loads were adjusted until the predicted organic nitrogen concentrations were similar to the observed concentrations. Organic nitrogen was calibrated first because none of the other state variables affect the organic nitrogen concentrations. Next, the benthic ammonia source rates were adjusted until the predicted ammonia nitrogen concentrations were similar to the observed concentrations. Then CBODu loads were adjusted until the predicted CBODu concentrations were similar to the observed concentrations. Finally, the SOD rates were adjusted until the predicted DO concentrations were similar to the observed concentrations. The DO was calibrated last because all of the other state variables affect DO.

3.8 Headwater Flow Rate (Data Type 20)

Inflow rates for Bayou Bonne Idee were based on the average flow reported by the USGS for the Tensas River at Tendal, LA (07369500) during the calibration period (August 9 to September 13, 1983). Based on the estimated flow per square mile of drainage area at the Tensas River gage, flow at the upstream end of the subsegment near the Village of Bonita was calculated using published drainage areas for Bayou Bonne Idee (USGS 1971). Because the stream is dammed and pumped for irrigation, incremental inflows were not added (i.e., it was assumed that irrigation pumpage and evaporation equaled incremental inflow along the stream). The data and calculations for the headwater flow rate are shown in Appendix I.

3.9 Headwater Water Quality (Data Types 20 and 21)

The headwater concentrations of DO, CBODu, organic nitrogen, and ammonia nitrogen were set to average concentrations at LDEQ station 0121 during the calibration period. This LDEQ station is located on Bayou Galion just upstream of its confluence with Bayou Bonne Idee and this water quality is considered to be similar to water quality expected at the upstream end of Bayou Bonne Idee. The LDEQ monitoring data at station 0121 included DO, TKN, nitrate + nitrite, and TOC. CBODu, ammonia nitrogen, and organic nitrogen were estimated using the relationships discussed in Section 3.2 of this report. The raw data for station 0121 are shown in Appendix C and the values used as model input are shown in Appendix F.

3.10 Point Source Inputs (Data Types 24 and 25)

Model inputs from the Village of Bonita STP were based on design flow and permit limits because no effluent data were available for the calibration period. The flow was set to the design flow and the CBODu concentration was set to the current permit limit for BOD_5 multiplied by an assumed CBODu:BOD_5 ratio of 2.3 (which is consistent with the LTP). The DO and ammonia nitrogen concentrations for the discharge were both set at 5 mg/L based on LTP guidance for advanced treatment. The organic nitrogen concentration was set at twice the ammonia nitrogen concentration (following typical LDEQ procedures for a pond treatment system). The nitrate+nitrite concentration for the discharge was set at the drinking water standard of 10 mg/L. The values used as model input are shown in Appendix F.

3.11 Model Results for Calibration

Plots of predicted and observed water quality for the calibration are presented in Appendix J and a printout of the LA-QUAL output file is included as Appendix K. The calibration was considered to be acceptable based on the amount of data that were available.

4.0 WATER QUALITY MODEL PROJECTION

EPA's regulations at 40 CFR 130.7 require the determination of TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. Therefore, the calibrated model was used to project water quality for critical conditions. The identification of critical conditions and the model input data used for critical conditions are discussed below.

4.1 Identification of Critical Conditions

Section 303(d) of the Federal Clean Water Act and EPA's regulations at 40 CFR 130.7 both require the consideration of seasonal variation of conditions affecting the constituent of concern and the inclusion of a MOS in the development of a TMDL. For the TMDLs in this report, analyses of LDEQ long-term ambient data were used to determine critical seasonal conditions. A combination of implicit and explicit MOS was used in developing the projection model.

Critical conditions for DO have been determined for Louisiana waterbodies in previous TMDL studies. The analyses concluded that the critical conditions for stream DO concentrations occur during periods with negligible nonpoint runoff, low stream flow, and high stream temperature.

When the rainfall runoff (and nonpoint loading) and stream flow are high, turbulence is higher due to the higher flow and the stream temperature is lowered by the cooler precipitation and runoff. In addition, runoff coefficients are higher in cooler weather due to reduced evaporation and evapotranspiration, so that the high flow periods of the year tend to be the cooler periods. DO saturation values are, of course, much higher when water temperatures are cooler, but BOD decay rates are much lower. For these reasons, periods of high loading are periods of higher reaeration and DO but not necessarily periods of high BOD decay.

LDEQ interprets this phenomenon in its TMDL modeling by assuming that the annual nonpoint loading, rather than loading for any particular day, is responsible for the accumulated benthic blanket of the stream, which is, in turn, expressed as SOD and/or resuspended BOD in the model. This accumulated loading has its greatest impact on the stream during periods of higher temperature and lower flow.

According to the LTP, critical summer conditions in DO TMDL projection modeling are simulated by using the annual 7Q10 flow or 0.1 cfs, whichever is higher, for all headwaters, and 90th percentile temperature for the summer season. For the Bayou Bonne Idee TMDL, model loading is from perennial tributaries, SOD, and resuspension of sediments.

In reality, the highest temperatures occur in July and August and the lowest stream flows occur in October and November. The combination of these conditions plus the impact of other conservative assumptions regarding rates and loadings yields an implicit MOS that is not quantified. Over and above this implicit MOS, an explicit MOS of 10% for NPS was incorporated into the TMDLs in this report to account for model uncertainty.

4.2 Temperature Inputs

The LTP (LDEQ 2001) specified that the critical temperature should be determined by calculating the 90th percentile seasonal temperature for the waterbody being modeled. LDEQ station 0127 was used to calculate a 90^{th} percentile summer temperature for the headwater and reaches 1, 2, and 3 (28.2° C). LDEQ stations 0125, 0126, and 0122 were used to calculate 90^{th} percentile summer temperatures for reaches 4 (30.3° C), 5 (30.8° C), and 6 (31.3° C), respectively. These values were specified in Data Type 11 in the model and are shown in Appendix L along with other input that were changed from the calibration to the projection. The 90^{th} percentile temperature calculations are shown in Appendix M.

Because Bayou Bonne Idee has a year round standard for DO, a winter projection simulation was not performed. As discussed above, the most critical time of year for meeting a constant DO standard is the period of high temperatures and low flows (i.e., summer).

4.3 Headwater Inputs

The inputs for the headwater for the projection simulation were based on guidance in the LTP. As specified in the LTP, the DO concentration for the headwater inflow was set to 90%

saturation at the critical temperature. Headwater concentrations for other parameters were set to calibration values.

There are no USGS flow gages and no published 7Q10 flows for Bayou Bonne Idee. However, a published 7Q10 value was available for the USGS gage for Tensas River at Tendal (07369500); this value was 4.3 cfs (Lee 2000). A 7Q10 flow per unit area was developed by dividing 4.3 cfs by the drainage area for this gage (309 mi^2). The 7Q10 flow for the Bayou Bonne Idee headwater was estimated by multiplying the 7Q10 flow per unit area times the headwater drainage area (approximately 2.1 mi^2), which yielded an inflow of approximately 0.03 cfs. Because the LTP specifies that the critical flow rate for summer should be set to the 7Q10 flow or 0.1 cfs, whichever is higher, the headwater flow rate in the projection simulation was set to 0.1 cfs. The values used as model input in the projection simulation are shown in Appendix L. The published 7Q10 information is shown in Appendix N.

4.4 Point Source Inputs

For the Village of Bonita STP, the flow was set to 125% of the design flow in order to incorporate an explicit 20% margin of safety. Water quality concentrations were based on current permit limits (the same values that were used in the calibration). The values used as model input in the projection simulation are shown in Appendix L.

4.5 Nonpoint Source Loads

Because the initial projection simulation was showing low DO values, the NPS loadings were reduced until all of the predicted DO values were equal to or greater than the water quality standard of 5.0 mg/L. The same percent reduction was applied to all components of the NPS loads (SOD, benthic ammonia source rates, and mass loads of CBODu and ammonia nitrogen). The values used as model input in the projection simulation are shown in Appendix L.

4.6 Other Inputs

The only model inputs that were changed from the calibration to the projection simulation were the inputs discussed above in Sections 4.2 through 4.5. Other model inputs (e.g., hydraulic and dispersion coefficients, decay rates, reaeration rates, etc.) were unchanged from the calibration simulation.

4.7 Model Results for Projection

A plot of predicted DO for the projection is presented in Appendix O and a printout of the LA-QUAL output file is included as Appendix P.

An NPS load reduction of approximately 82% was required to bring the predicted DO values to at least 5.0 mg/L. This percentage reduction for NPS loads represents a percentage of the entire NPS loading, not a percentage of the manmade NPS loading. The NPS loads in this report were not divided between natural and manmade because it would be difficult to estimate natural NPS loads for the study area. Point source reductions were not necessary because the lowest predicted DO values occurred more than 50 km downstream of the Village of Bonita STP.

5.0 TMDL CALCULATIONS

5.1 DO TMDL

A total maximum daily load (TMDL) for DO has been calculated for the Bayou Bonne Idee subsegment based on the results of the projection simulation. The DO TMDL is presented as oxygen demand from CBODu, organic nitrogen, ammonia nitrogen, and SOD. A summary of the loads for Bayou Bonne Idee is presented in Table 5.1.

The TMDL calculations were performed using a FORTRAN program that was written by FTN personnel. This program reads two files; one is the LA-QUAL output file from the projection simulation and the other is a small file with miscellaneous information needed for the TMDL calculations (shown in Appendix Q). The output from the program is shown in Appendix R and the source code for the program is shown in Appendix S.

Table 5.1. DO TMDL for subsegment 080902 (Bayou Bonne Idee).

	Oxygen demand (kg/day) from:				**Total oxygen demand (kg/day)**
	CBODu	**Organic N**	**Ammonia N**	**SOD**	
WLA for point sources	6.36	11.97	5.99	NA	24.32
MOS for point sources	1.59	2.99	1.50	NA	6.08
LA for NPS	1,810.91	265.84	0.10	7,781.37	9,858.22
MOS for NPS	201.21	29.54	0.01	864.60	1,095.36
Total maximum daily load	2,020.07	310.34	7.60	8,645.97	10,983.98

The oxygen demand from organic nitrogen and ammonia nitrogen was calculated as 4.33 times the nitrogen loads (assuming that all organic nitrogen is eventually converted to ammonia). The value of 4.33 is the same ratio of oxygen demand to nitrogen that is used by the LA-QUAL model. For the SOD loads, a temperature correction factor was included in the calculations (in order to be consistent with LDEQ procedures).

5.2 Nutrient TMDL

Because Bayou Bonne Idee was on the 303(d) List for nutrients as well as DO (see Table 1.1), a nutrient TMDL was also developed. As discussed in Section 2.2, Louisiana has no numeric standards for nutrients, but has a narrative standard that states that "the naturally occurring range of nitrogen to phosphorus ratios shall be maintained" (LDEQ 2000). For this TMDL, nutrients were defined as total nitrogen (organic nitrogen plus ammonia nitrogen plus nitrate/nitrite nitrogen) and total phosphorus. The value used for the naturally occurring nitrogen to phosphorus ratio was 8.0. This ratio was based on LDEQ reference stream data for the Upper Mississippi Alluvial Plain ecoregion (Smythe 1999). These data are shown in Appendix T.

The first step in calculating the nutrient TMDL was to determine the loads of total nitrogen (TN) that were simulated in the projection model. The loads in the projection model represent the maximum allowable loads that will maintain DO standards. Then the allowable loads of total phosphorus (TP) were calculated by dividing the nitrogen loads by the naturally occurring ratio of TN to TP. The resulting loads of TN and TP for the Bayou Bonne Idee subsegment are presented in Table 5.2.

Table 5.2. Nutrient TMDL for subsegment 080902 (Bayou Bonne Idee).

	Organic N (kg/day)	**Ammonia N (kg/day)**	**NO_2+NO_3 N (kg/day)**	**Total N (kg/day)**	**Total P (kg/day)**
WLA for point sources	2.76	1.38	2.76	6.90	0.86
MOS for point sources	0.69	0.35	0.69	1.73	0.22
LA for NPS	61.40	0.02	0.01	61.43	7.68
MOS for NPS	6.82	0.00	0.00	6.82	0.85
Total Maximum Daily Load	71.67	1.75	3.46	76.88	9.61

5.3 Nitrogen and Phosphorus TMDLs

In the 303(d) List (Table 1.1), the suspected causes of impairment for Bayou Bonne Idee included nitrogen and phosphorus as well as nutrients. Including nitrogen and phosphorus as suspected causes of impairments was redundant because the primary nutrients of interest for waterbodies such as Bayou Bonne Idee are nitrogen and phosphorus. The allowable loadings of nitrogen and phosphorus for Bayou Bonne Idee were calculated for the nutrient TMDL and are shown in Table 5.2.

5.4 Ammonia Toxicity Calculations

Although subsegment 080902 is not on a 303(d) List for ammonia, the ammonia concentrations predicted by the projection model were checked to make sure that they did not exceed EPA criteria for ammonia toxicity (EPA 1999). The EPA criteria are dependent on temperature and pH. The water temperatures used to calculate the ammonia toxicity criteria for Bayou Bonne Idee were the same as the critical temperatures used in the projection simulation. For pH, an average of the values measured at LDEQ station 0127 during the calibration period was used for reaches 1 through 3. The average pH values during the calibration period at LDEQ stations 0125, 0126, and 0122 were used for reaches 4, 5, and 6, respectively. The resulting criteria were $2.0 mg/L of ammonia nitrogen. The instream ammonia nitrogen concentrations predicted by the LA-QUAL model (#1.06 mg/L) were well below the criteria. This indicates that the ammonia nitrogen loadings that will maintain the DO standard are low enough that the EPA ammonia toxicity criteria will not be exceeded under critical conditions. The ammonia toxicity calculations are shown in Appendix U.

5.5 Summary of Load Reductions

In summary, the projection modeling used to develop the TMDLs above showed that NPS loads need to be reduced by an average of approximately 82% along Bayou Bonne Idee to maintain the DO standard. No point source reductions are necessary.

5.6 Seasonal Variation

As discussed in Section 4.1, critical conditions for DO in Louisiana waterbodies have been determined to be when there is negligible nonpoint runoff and low stream flow combined with high water temperatures. In addition, the model accounts for loadings that occur at higher flows by modeling sediment oxygen demand. Oxygen demanding pollutants that enter the waterbodies during higher flows settle to the bottom and then exert the greatest oxygen demand during the high temperature seasons.

5.7 Margin of Safety

The MOS accounts for any lack of knowledge or uncertainty concerning the relationship between load allocations and water quality. As discussed in Section 4.1, the highest temperatures occur in July through August, the lowest stream flows occur in October through November, and the maximum point source discharge occurs following a significant rainfall, i.e., high-flow conditions. The combination of these conditions, in addition to other conservative assumptions regarding rates and loadings, yields an implicit MOS which is not quantified. In addition to the implicit MOS, the TMDLs in this report include an explicit MOS of 10% for NPS loads.

6.0 SENSITIVITY ANALYSES

All modeling studies necessarily involve uncertainty and some degree of approximation. It is therefore of value to consider the sensitivity of the model output to changes in model coefficients, and in the hypothesized relationships among the parameters of the model. The sensitivity analyses were performed by allowing the LA-QUAL model to vary one input parameter at a time while holding all other parameters to their original value. The projection simulation was used as the baseline for the sensitivity analysis. The percent change of the model's minimum DO projections resulting from each parameter change is presented in Table 6.1. Each parameter was varied by "30%, except for temperature, which was varied "2ºC.

Values reported in Table 6.1 are sorted by percentage variation of minimum DO from smallest percentage variation to largest. The parameters to which DO was most sensitive were reaeration, SOD, and temperature.

Table 6.1. Summary of results of sensitivity analyses.

Input Parameter	Parameter Change	Predicted minimum DO (mg/L)	Percent Change in Predicted DO (%)
Baseline	-	5.09	N/A
BOD Decay Rate	+30%	5.09	<1
BOD Decay Rate	-30%	5.09	<1
Depth	+30%	5.09	<1
Depth	-30%	5.09	<1
Headwater Flow	+30%	5.09	<1
Headwater Flow	-30%	5.09	<1
NH_3 Decay Rate	+30%	5.09	<1
NH_3 Decay Rate	-30%	5.09	<1
Organic N Decay Rate	+30%	5.09	<1
Organic N Decay Rate	-30%	5.09	<1
Waste Load BOD	+30%	5.09	<1
Waste Load BOD	-30%	5.09	<1
Waste Load DO	+30%	5.09	<1
Waste Load DO	-30%	5.09	<1
Waste Load Flow	+30%	5.09	<1
Waste Load Flow	-30%	5.09	<1
Waste Load NH_3	+30%	5.09	<1
Waste Load NH_3	-30%	5.09	<1
Waste Load Organic N	+30%	5.09	<1
Waste Load Organic N	-30%	5.09	<1
Velocity	+30%	5.02	1
Velocity	-30%	5.16	1
Initial Temperature	+2EC	5.52	8
Initial Temperature	-2EC	4.65	9
Reaeration	+30%	5.62	10
SOD	+30%	4.47	12
SOD	-30%	5.71	12
Reaeration	-30%	4.10	19

7.0 OTHER RELEVANT INFORMATION

This TMDL has been developed to be consistent with the antidegradation policy in the LDEQ water quality standards (LAC 33:IX.1109.A).

Although not required by this TMDL, LDEQ utilizes funds under Section 106 of the Federal Clean Water Act and under the authority of the Louisiana Environmental Quality Act to operate an established program for monitoring the quality of the state's surface waters. The LDEQ Surveillance Section collects surface water samples at various locations, utilizing appropriate sampling methods and procedures for ensuring the quality of the data collected. The objectives of the surface water monitoring program are to determine the quality of the state's surface waters, to develop a long-term data base for water quality trend analysis, and to monitor the effectiveness of pollution controls. The data obtained through the surface water monitoring program is used to develop the state's biennial 305(b) report (Water Quality Inventory) and the 303(d) List of impaired waters. This information is also utilized in establishing priorities for the LDEQ NPS program.

The LDEQ has implemented a watershed approach to surface water quality monitoring. Through this approach, the entire state is sampled over a five-year cycle with two targeted basins sampled each year. Long-term trend monitoring sites at various locations on the larger rivers and Lake Pontchartrain are sampled throughout the five-year cycle. Sampling is conducted on a monthly basis or more frequently if necessary to yield at least 12 samples per site each year. Sampling sites are located where they are considered to be representative of the waterbody. Under the current monitoring schedule, targeted basins follow the TMDL priorities. In this manner, the first TMDLs will have been implemented by the time the first priority basins will be monitored again in the second five-year cycle. This will allow the LDEQ to determine whether there has been any improvement in water quality following establishment of the TMDLs. As the monitoring results are evaluated at the end of each year, waterbodies may be added to or removed from the 303(d) List. The sampling schedule for the first five-year cycle is shown below. The Ouachita River Basin will be sampled again in 2004.

1998 – Mermentau and Vermilion-Teche River Basins
1999 – Calcasieu and Ouachita River Basins
2000 – Barataria and Terrebonne Basins
2001 – Lake Pontchartrain Basin and Pearl River Basin
2002 – Red and Sabine River Basins

(Atchafalaya and Mississippi Rivers will be sampled continuously.)

In addition to ambient water quality sampling in the priority basins, the LDEQ has increased compliance monitoring in those basins, following the same schedule. Approximately 1,000 to 1,100 permitted facilities in the priority basins were targeted for inspections. The goal set by LDEQ was to inspect all of those facilities on the list and to sample 1/3 of the minors and 1/3 of the majors.

8.0 PUBLIC PARTICIPATION

When EPA establishes a TMDL, 40 CFR §130.7(d)(2) requires EPA to publicly notice and seek comment concerning the TMDL. Pursuant to an October 1, 1999 Court Order, this TMDL was prepared under contract to EPA. After development of the draft of this TMDL, EPA commenced preparation of a notice seeking comments, information, and data from the general and affected public. Comments and additional information were submitted during the public comment period and this TMDL was revised accordingly. Responses to these comments and additional information are included in Appendix V. EPA has transmitted this revised TMDL to LDEQ for incorporation into LDEQ's current water quality management plan.

9.0 REFERENCES

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APPENDICES A THROUGH U ARE AVAILABLE THROUGH EPA UPON REQUEST

APPENDIX V

Responses to Comments

COMMENTS AND RESPONSES
BAYOU BONNE IDEE TMDLs FOR DO AND NUTRIENTS
May 28, 2002

EPA appreciates all comments concerning these TMDLs. Comments that were received are shown below with EPA responses or notes inserted in a different font.

GENERAL COMMENTS FROM LOUISIANA DEPARTMENT OF ENVIRONMENTAL QUALITY (LDEQ):

Note: LDEQ submitted one document containing comments on 98 TMDLs for various pollutants and subsegments throughout the Ouachita and Calcasieu basins. Only the portions of that comment document that apply to the DO and nutrient TMDLs in the Ouachita basin (10 subsegments) are shown below. Some of the general comments may not apply to this report.

The Louisiana Department of Environmental Quality hereby submits comments on the 98 TMDLs and the calculations for these TMDLs prepared by EPA Region 6 for waters listed in the Calcasieu and Ouachita river basins, under section 303(d) of the Clean Water Act. Listed below are general comments.

1. Many of these TMDLs are based on models using historical water quality data gathered at a single or small number of locations rather than survey data gathered at sites spaced throughout the waterbody. The hydraulic information used was generally an average value or estimated value, not taken at the same time as the water quality data. The calibrations are inadequate due to the lack of appropriate hydrologic data and the paucity of water quality data. The resulting TMDLs are invalid. LDEQ does not accept these TMDLs.

Response: The TMDLs were based on existing data plus information that could be obtained with available resources. Each model was developed using the most appropriate hydraulic information and water quality data that were available. A rationale was provided for data use and assumptions and limitations were given. Although LDEQ typically collects more data for model calibration than what was available for calibration of most of these models, EPA considers these model calibrations and the resulting TMDLs to be valid.

2. LDEQ does not consider any of these waters to be impaired due to low dissolved oxygen, nutrients, or ammonia. Many of these waters simply have inappropriate standards and criteria. The resources spent on developing these TMDLs could have been far more effectively and wisely spent on reviewing, approving, and assisting in the development of appropriate standards and criteria for these waters through the UAA process.

Response: TMDLs were developed for these subsegments based on the requirements of Section 303(d) of the Clean Water Act and regulations at 40 CFR 130.7 and the suspected causes of impairment (organic enrichment/low DO and/or nutrients) for each subsegment in the EPA Modified Court Ordered 303(d) List. TMDLs must be established to meet existing water quality standards. If it is determined that a standards changes is appropriate, the TMDL can be revised to reflect that change.

3. CBODu and NH3-N were estimated from surrogate parameters rather than actual measured data for most of the TMDLs. The TMDL report uses the LDEQ's multi-basin loading database's median ratio values between the ultimate loads and the proposed surrogates. This data was based on the measured data from the last two years of LDEQ water quality surveys. LDEQ objects to the correlation of TOC to CBOD and NH3-N to TKN unless these correlations are taken from water quality data on the modeled waterbody. Our studies have shown only a moderate correlation between these parameters within the same waterbody, however when this correlation was attempted across waterbodies, extreme variability was seen and the correlations were not judged valid. It is possible that a combination of surrogates will obtain a better correlation, such as TOC along with color, turbidity, pH, etc. LDEQ is currently researching these options.

Response: EPA agrees that it would be ideal to have data collected from each modeled waterbody for relating TOC to CBOD and NH3-N to TKN. However, none of these subsegments had sufficient data from which these relationships could be developed. Relationships with surrogate parameters were used only when data for the desired parameter was not available.

4. BOD decay rates were estimated from surrogate parameters rather than actual measured data for most of the TMDLs. The TMDL report uses the LDEQ's multi-basin loading database's median values. This data was based on the measured data from the last two years of LDEQ water quality surveys. It has been LDEQ's experience that these rates vary significantly from waterbody to waterbody and frequently vary significantly within the same waterbody. LDEQ objects to using surrogate data without regard for specific waterbody conditions for these parameters.

Response: Due to the schedule and level of resources available for this project, it was not feasible to perform long term BOD time series analyses on samples from these waterbodies. Given this situation, using LDEQ’s database was considered the best approach for estimating decay rates.

5. A winter projection model was not developed for most of the TMDLs. Winter projection models must be developed to address seasonality requirements of the Clean Water Act. Where point sources have seasonally variable effluent limitations or such seasonal variations are proposed, a winter projection model is required to show that standards are met year-round.

Response: As discussed in Section 4.2 of each report, summer is the most critical season for meeting the year round standard for DO for these subsegments. Therefore, the summer simulation satisfies the seasonality requirements of the Clean Water Act. The available information for point source discharges indicated that the facilities discharging to these waterbodies do not have seasonal permit limits. If any of these facilities wishes to pursue seasonal permit limits, then LDEQ or the permittee can re-run the model to develop seasonal wasteload allocations.

6. LDEQ takes exception to the calculation of a TMDL based on TN/TP ratios derived from waterbodies other than the modeled waterbody. It is LDEQ's experience that the natural allowable TN/TP ratio is waterbody-specific and can vary dramatically between streams.

Response: These nutrient TMDLs were developed using naturally occurring ratios of nitrogen to phosphorus based on Louisiana’s narrative water quality standard for nutrients. These ratios were calculated using reference stream data rather than long term monitoring data for each subsegment because the reference stream data were considered to be more appropriate for naturally occurring conditions.

7. LDEQ has not adopted the EPA recommended ammonia criteria (1999) and takes exception to its use in these TMDLs. In general, LDEQ does not accept EPA's use of national guidance for TMDL endpoints. The nationally recommended criteria do not consider regional or site- specific conditions or species and may be inappropriately over protective or under protective. No ammonia nitrogen toxicity has been demonstrated or documented in any of the waterbodies in these TMDLs. The general criteria (in particular, LAC 33:IX.1113.B.5) require state waters be free from the effects of toxic substances.

Response: Ammonia toxicity calculations were performed to ensure that the ammonia loadings that will maintain DO standards will not cause any exceedences of the ammonia toxicity criteria. National guidance for ammonia toxicity was used in the absence of any numerical state water quality standards for ammonia. EPA believes that this evaluation offers assurances that waters will continue to be free from the effects of toxic substances.

8. Algae were not simulated. Was there evidence that algae did not have an impact on the waterbody? Did the contractor have any Chlorophyll a measurements on which to base this determination?

Response: For most of these subsegments, the effects of algae were not simulated in the models because there were no data to clearly demonstrate a need for including algae and the models calibrated well without including algae (i.e., the models were calibrated without having to use unreasonable coefficients to compensate for algal effects).

SPECIFIC COMMENTS FROM LDEQ FOR BAYOU BONNE IDEE:

1. The calibration simulation must be used as the baseline for the sensitivity analysis, not the projection simulation. LDEQ requests that all TMDLs be revised in this regard.

Response: It is considered acceptable to perform the sensitivity analysis using either the calibration or the projection as a baseline. However, EPA will consider this in future development of TMDLs in Louisiana.

2. Based upon an 82% reduction in loads and the fact that there are four dams located in this subsegment, these results suggest that a dissolved oxygen standard criteria change should be investigated. This was not noted in the report.

Response: The appropriateness of the DO standard was not mentioned in the report because the scope of this report was only the development of necessary TMDLs. Evaluation of the DO standard can be performed by LDEQ and documented in a separate report.

3. With four dams present on the stream, a newer version of Laqual could have been used that included dam functionality.

Response: The version of LA-QUAL that was used was the most recent version available on the LDEQ web site at the beginning of this project. This version includes all model processes that are needed for Bayou Bonne Idee.

4. The margin of safety for both point sources and non-point sources should be 20%.

Response: The nonpoint margin of safety (MOS) was set to 10% based on other TMDLS on Louisiana waterbodies that have either been developed by LDEQ or approved by LDEQ. Eleven TMDL reports from LDEQ's website were reviewed to examine the explicit MOS for nonpoint sources. All 11 of these TMDLs were for oxygen demanding substances. The explicit MOS for nonpoint sources was set to 20% for 2 reports, 10% for 3 reports, and 0% for 6 reports. Therefore, the value of 10% was considered to be a typical value that was acceptable. However, EPA will consider this in future development of TMDLs in Louisiana.